An Assessment of Russian Nuclear Materials Safeguards

Susan Voss
Global Nuclear Network Analysis, LLC
PO Box 4850, Los Alamos, NM 87544

ABSTRACT

Since the early 1990's, prior to the demise of the Former Soviet Union, there has been considerable international concern over the security of the Russian nuclear weapons and nuclear materials. After the breakup, the earlier system of personal control of material was no longer adequate likewise the state controls on the individual were relaxed or eliminated altogether. Having been one of the first Americans's to have the opportunity to work directly with the Russian nuclear institutes on the Topaz space reactor program and later on the Material Protection, Control and Accountability (MPC&A) program I witnessed firsthand the critical needs facing the Russian institutes in nuclear material safeguards. This provided a direct view of the financial issues facing Russia from guards sleeping at their posts to impressive and innovative nuclear systems whose missions had been cancelled. Over the past 18 years significant changes have been implemented within Russia including the handling and dismantling of tens of thousands of nuclear weapons, the rebuild of many thousand new weapons and the processing, packaging and storage of nuclear materials or conversely the down-blending of hundreds of metric tons of special nuclear materials. Material safeguards have steadily improved and the legal basis for physical protection and material accounting has been established. The purpose of this paper is to provide an overview of the changes within the Russian nuclear complex, their nuclear stockpile and material safeguards. Furthermore the paper will show how the Russian government planned expansion of nuclear power also incorporates improvements in their nuclear material safeguards, the environment and consolidation. These large changes constitute a new baseline for nuclear agencies within Russia, a break from the past that needs to be recognized and appreciated, while opening up new opportunities for US and international nonproliferation and counter-terrorism programs.

INTRODUCTION

The Russian government has established a set of safeguard guidelines, a legal framework, review procedures and methods for multi-agency, large scale exercises for testing the readiness and coordination between agencies for their key nuclear sites. This set of activities is the basis for nuclear safeguards within Russia and was established in part through the work with the US/Russian MPC&A program and through separate efforts by the Russian government. The Russian safeguards program and the US MPC&A program have been progressing in parallel since the 1990's. The US/Russian MPC&A program has covered the development of guidelines and regulations, computerized material and accounting at the institute and state-level, operational equipment, a strong training program and the implementation of engineered high-tech solutions. The Russian program appears to have greater emphasis on human and administrative controls. The average wages in Russia continue to be relatively low and therefore their emphasis appears to be on the use of human controls and less on the use of technical solutions that require additional costs to operate, certify and maintain. The Russian approach is culturally specific to their current economic circumstances.

SPECIAL NUCLEAR MATERIALS IN RUSSIA

Russia is currently assessed as having the largest quantity of weapons-usable nuclear material of any country in the world. According to Cochran[i] the Union of Soviet Socialist Republic (USSR) nuclear stockpile peaked in 1986 with 45,000 warheads and declined more than 20% to 32,000 warheads by May 1993. The Russian have declared that their nuclear weapons have a lifetime of 10 to 15 years and have maintained a program of rebuild during these turbulent times. In 2006, the Stockholm International Peace Institute (SIPRI) estimated that Russia had 3352 strategic nuclear weapons (SNW) and 2330 nonstrategic nuclear weapons (NSNW) for a total of 5682[ii]. If we assume additional nuclear weapons are awaiting assembly or disassembly bringing the estimated number to 8000 nuclear weapons, this would imply that roughly $1/5^{th}$ of all nuclear weapons related materials is still used for the stockpile and $4/5^{th}$'s has been removed from the nuclear weapons stockpile. If we further assume that an additional $1/5^{th}$ will be held for future contingency for nuclear weapons then roughly $3/5^{th}$'s of the total amount of nuclear materials would require transition from the weapons program to long-term storage, use in the civilian or defense fuel program or down-blended for sale or use in the nuclear fuel cycle.

It is estimated that the USSR had produced a total of 1200 MT of high enriched uranium (40% to 90%)[iii] through 1988 and approximately 125 to 150 MT of weapons-grade plutonium by 1993.[iv] [v] In addition, Russia has produced an estimated ~40 MT of civilian plutonium from the separation of the VVER-440, submarine, ice breaker, research reactors and BN fast reactor fuel and additional weapons-grade plutonium (~90% Pu-239 and above) in their production reactors. Under the US/Russian high enriched uranium (HEU) agreement over 300 MT of 90% HEU has been down-blended to low enriched uranium (LEU) and additional HEU and medium enriched uranium (>20% and <80%) has been used for their own reactor fuel needs. This would imply that Russia has less than 900 MT of HEU/MEU and approximately 200 MT of weapons, civilian and Plutonium Production Reactor Agreement plutonium. Using the simple fractions of nuclear weapons released from the nuclear stockpile outlined above, this would imply there is less than 720 MT of HEU (40% to 90%) and around 90 MT of weapons-grade plutonium outside of the weapons program.

The Russian complex can be broken into three primary types of sites: transitory, long-term storage and research and development. A specific institute can have all three functions or a single function. For example, the Mayak Production association has three primary functions including:

1. Transitory: HEU/LEU blend-down where the material arrives on the site, it undergoes processing and is sent to the next site for conversion and down-blending.
2. Long-term storage: Civilian plutonium is stored long-term at the RT-1 site and weapons plutonium is to be stored at the Fissile Material Storage Facility.
3. R&D: Mayak has facilities for the R&D for MOX fuel.

Each type of site therefore has different requirements for the safeguarding of nuclear materials within the Russian nuclear complex based upon the types of materials at the site, the quantity of material, the function of the site. There are an estimated 57 non-weapon sites within Russia that have HEU or MEU and an estimated 12 sites with plutonium. Roughly 30 to 40 MT of HEU is transferred between approximately 10 sites per year as part of the US/Russian HEU down-blend program and for Russian fuel manufacturing. This does not include the amount of HEU that is transferred for the assembly and disassembly of nuclear weapons. Approximately 1 to 1.5 MT of civilian plutonium is produced per year and through May of 2008 approximately 1 MT of weapons-grade plutonium was produced per year. The

amount of weapons-grade plutonium produced per year has been reduced to a few hundred kilograms with the shutdown of the Tomsk production reactors. Ensuring nuclear material protection during transportation, transfer to multiple sites for processing, conversion and down-blending or reprocessing and preparation for storage has been and will continue to be a large task for Rosatom.

ROSATOM STATE CORPORATION

Sergey Kiriyenko was appointed the head of the Russian Atomic Agency, Rosatom, on November 15, 2005. Kiriyenko established a broad plan to convert Rosatom and the associated institutes from a Federal Agency to a private corporation while retaining the federal functions. As the head of Rosatom, Kiriyenko brought in a team of business specialists to run key organizations and institutes, while maintaining many of the nuclear professions within their senior positions. Prior to Kiriyenko's leadership, senior positions were filled by the nuclear experts from the technical institutes. This led to a strong sense of protecting specific institutes and traditional thinking. Kiriyenko has lined up the new Rosatom Corporation with the goal of meeting the nation's aggressive energy and economic goals.

Many of the new generation leaders are business people with an eye for capitalizing their existing infrastructure and capabilities for economic growth through the increased international need for energy. Nuclear power development and expansion is an integral part of Russia's overall energy and national economic strategy, thereby ensuring adequate funding to acquire the key elements of the nuclear power industry. In 2007 and 2008, as Rosatom morphed into its new conception of a State Corporation and began reacquiring many of the key nuclear manufacturing and construction companies and institutes. The commercial ventures will be managed within Rosatom by AtomEnergoProm Corporation by offering end-to-end service including: uranium mining; uranium conversion; uranium enrichment; fuel fabrication; reactor design, manufacturing, construction and operation; spent nuclear fuel take back and reprocessing.

ROSATOM SAFEGUARDS

Based upon the programs that Kiriyenko has developed, it appears that he understands that to become accepted as one of the key suppliers of international nuclear technology and fuel it is imperative that Rosatom Corporation be viewed as highly professional and capable. This requires the implementation and enforcement of safeguard standards. It also requires that nuclear diversions from Russian institutes are a thing of the past and the nuclear material is well accounted and controlled. And finally, Russia cannot be seen as a supplier of potentially proliferant technology, such as Iran. It is clear from the specific steps that have been implemented and the proposed budgets that these issues are of primary concern to Kiriyenko as he continues to guide the future of the Rosatom Corporation.

The Russian government has made significant progress in establishing their national nuclear MPC&A system. They have created a foundation for the establishment of standards and have implemented procedures for review and evaluation. They have steadily built their foundation and have demonstrated their readiness to take over the long-term responsibility for its implementation through the approval of the Federal Target Program (FTP) on Nuclear and Radiation Safety in conjunction with the expansion of their nuclear power program. A summary of the important changes to nuclear safeguards and nonproliferation since 2000 is listed below with additional details on each item below:

1. Establishment and implementation of Russian nuclear safeguard requirements;
2. Reduction in the number of sites within the nuclear weapons complex.
3. Conducting audits of the sites against the physical protection requirements including reported removal of management for noncompliance to MPC&A;
4. Large scale, multi-agency security exercises at the Rosatom sites; and

5. New FTP for 132 B-Rubles (~$5.5B) for 7 years to address nuclear safety and security.
6. Increased role of the FSB within domestic nuclear terrorism and at the nuclear site level.

1. Russian Nuclear Safeguard Requirements: Establishment of the Russian nuclear safeguard requirements forms the foundation for the nuclear material safeguards program for which each site is evaluated, including:

1. 9/1994 Presidential Decree on the priority measures to improve the nuclear material accounting and protection systems.
2. 3/7/1997 Decree #264 Regarding Approval of Rules of Physical Protection of Nuclear Materials, Nuclear Fuel and Points of Storage of Nuclear Material.
3. 10/10/2001 Decree #550 On Approving the General Requirements of Physical Protection Systems at Minatom's Nuclear Hazard Facilities.
4. 12/4/2003 Fundamentals of State Policy in the Field of Ensuring the Nuclear and Radiation Safety of the Russian Federation through the Year 2010 and beyond. And the 12/2/2005 Plan for Measures for Implementation of the 12/4/2003 Policy.

The legal framework was established with the support of the US/Russian MPC&A program and adopted legally by the Russian government. Rosatom, the Federal Service for Supervision of Environment, Technology and Nuclear Management (Rostekhnadzor), the Federal Security Service (FSB) and external teams have been conducting safeguard audits including physical protection, and material accounting and control at Rosatom sites since 1999 through the present day. The importance for the safeguards at the nuclear facilities is clear based upon the number of domestic terrorist attacks suffered within Russia since 1999, including:

1. September 9, 1999 Chechen attack on Moscow apartment buildings.
2. October 2, 2000 Chechen attack on the Moscow Dubrovka theater, and
3. September 1, 2004 Chechen attack on the Beslan School.

It has been reported that the Chechen groups have considered targeting nuclear assets as well. It was reported that prior to the attack on the Moscow theater, the Chechen group had also considered the seizure of at least one of the nuclear reactors at the Kurchatov Institute within Moscow, but after casing the site determined the security was too tight.[vi] On October 25, 2001, the Head of the 12th Main Directorate responsible for nuclear weapons reported that there had been two attempts to perform reconnaissance at nuclear storage facilities in February and April of 2001.[vii] It was later reported that Minatom established a task force to address these specialized security concerns and issues.

2. Reduction of the Number of Sites Working on Nuclear Weapons: On June 24, 1998 the Russian government approved the implementation plan for the Restructuring and Conversion of the Defense Industry. Former Deputy Minister of Atomic Energy, L. Ryabev, provided an overview of the key changes during his presentation during the fall of 1999 Carnegie Institute conference that included reducing the number of nuclear weapon assembly sites from four to two, the number of nuclear component sites from two to one, and to end the production of plutonium. These changes reduced the number of sites handling and storing nuclear weapons materials and reduced the transportation routes for nuclear weapons materials and nuclear weapons.

3. Action Plans for Identified Deficiencies: Rosatom, Rostekhnadzor, FSB and other experts have been conducting audits at the nuclear sites where action plans are established to deal with identified deficiencies. In one case, it is reported that an institute director was removed based upon his poor record of MPC&A (these charges were later refuted as incorrect reporting but they do appear potentially valid). Examples include:

A. It was reported in November 2005, Rosatom lead an inspection team consisting of 24 auditors who spent two weeks reviewing the security at the Siberian Chemical Combine (SCC). The deficiencies were to be addressed in future site planning.[viii] [ix]

B. It was reported that the Director of the Bochvar Institute was dismissed on March 13, 2007 reportedly due to:

"The action followed a complaint … lodged by the oversight agency Rostekhnadzor's Central Interregional Territorial District, specifying " 'violations of the schedule and procedure for conducting physical inventory, and of the rules for making confirmatory measurements of nuclear materials during the inter-balance period. Rostekhnadzor found that the Institute has no system for quality control of measurements of nuclear materials and the use of access control equipment; there is no system for professional training and checking the knowledge of personnel responsible for implementing accounting and control of nuclear materials and radioactive substances.."[x]

A. Putilov, the technical science director to Rosatom was Bochvars director's replacement. Putilov later denied that there had been any problems and that this was a false report. If indeed it did occur, it would represent a positive step in enforcing institutional issues with MPC&A within Rosatom at the very core– within the senior management.

C. In 2007, the head of Rostekhnadzor approved the plans to ascertain compliance with "ecological, industrial and radiation safety requirements." In 2007 there were 14 checks and inspections planned including the Beloyarsk Nuclear Power Plant (NPP), the Bochvar institute, the Mayak Production Association, and the Elektrostal fuel fabrication plant.[xi] In March 2007, it was reported that Rostekhnadzor planned to have in-depth inspections of the state accounting and control at the facilities under its purview.[xii]

One area of future concern will be the continued independence of the Rostekhnadzor to perform reviews in the face of the new Federal Target Program for Nuclear Power Development. There will be tremendous pressure from many parts of the Federal government to not limit progress in the advancement of the domestic and international program. This may offer opportunities for other countries independent nuclear review organizations such as the US Nuclear Regulatory Committee (NRC) to work with Rostekhnadzor, Rosatom and AtomEnergoProm. Maintaining a strong independent regulatory organization will be critical for AtomEnergoProm in their international nuclear program.

4. Large Scale Exercises: The Russian government has staged a number of large-scale, multi-agency exercises simulating terrorist attacks on nuclear material transportation and site security. These provide a mechanism for the Russian government to evaluate roles of the various agencies and to test effectiveness of existing integration. Examples include:

A. 10/12/1999 Ural-99 exercise of a terrorist group train derailment.

B. September 21, 2000 terrorist exercise at Tomsk-2000.

C. 10/17/2000 the FSB anti-terrorist exercise at the Ural Electrochemical Integrated Plant (UEIP).

D. June 25, 2002 Mining and Chemical Combine (MCC) emergency response exercise of nuclear material transportation.

E. 12/25/2002 FSB test at MCC with mock bomb at the spent nuclear fuel facility.

5. Federal Target Programs for the Nuclear Industry: The Russian government has established a number of high priority programs to be funded over the next 5 to 10 years in support of their overall national defense and economic growth in the areas of science, technology and energy. Included within these plans is a nuclear power program to develop and build nuclear power plants domestically and internationally. The domestic nuclear power plants are planned to increase the share of domestic electricity from NPPs from the current 16% to 25% by 2030 with the planned construction of 40 nuclear power plants during a period when the majority of their RBMK NPPs that account for 48% of the total number of NPPs will be shutdown. By increasing the share of electricity production to nuclear power it will allow the Russian government through its State Corporations to increase the amount of oil and gas that can be sold internationally. The 1,471 B Ruble (~$55.5B) FTP for NPP will also stimulate all areas of mining, manufacturing, banking, science, technology and construction. Roughly half of the funding for this FTP is to come from the Federal budget and half from the nuclear sector budget and private investment. This FTP will impact many of the key sectors within the Russian economy.

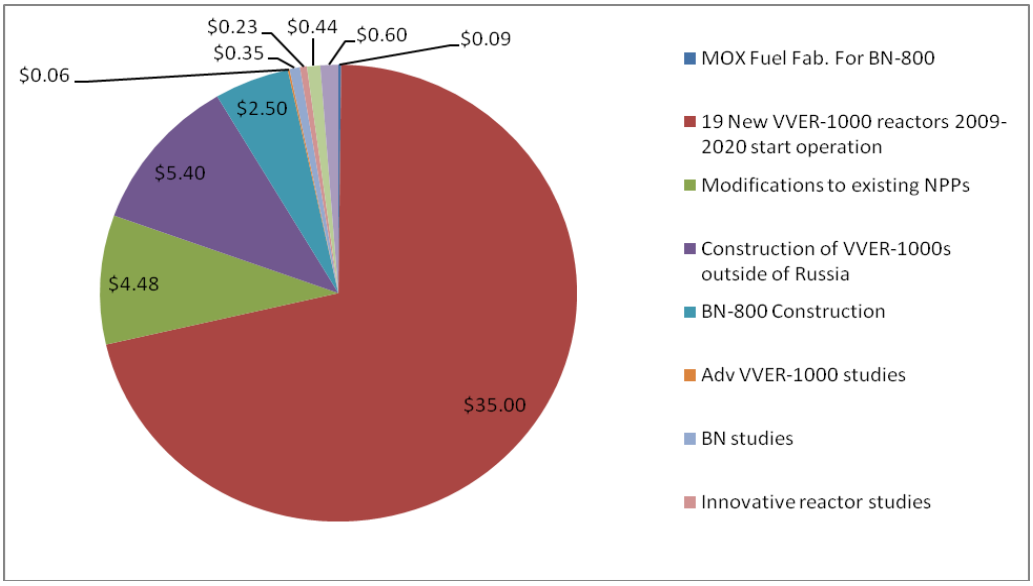

Figure 1: Overview of the Investment Strategy for the Russian NPP Development Program ($B based upon a 26.5 R/$)[xiii]

To implement the FTP for nuclear power, the Russian government passed the Tunnel Law that approves the establishment of AtomEnergoProm within Rosatom and the transfer of 55 State Unitary Enterprises to become part of the new corporation. This change allows government institutes to be converted to a private corporation that is 100% owned by the government. This has many advantages for investments. On November 13, 2007 the law was approved by the State Duma to convert all of Rosatom, including nuclear weapons and civilian power, into a state corporation. One December 12, 2007 S. Kiriyenko was appointed the new head of the corporation.

Critical to the success of this new state corporation and the proposed investment of billions of rubles for the development of nuclear power is ensuring the security of the nuclear material and reduction of the ecological impact. In short, their goal is to be an internationally viable corporation. On July 13, 2007 the 132B ruble (~$5.5B) FTP on Nuclear and Radiation Safety was approved. This provides funding for nuclear MPC&A. It includes material consolidation and reduction. It also covers site

clean-up, spent nuclear fuel storage and site restoration. This FTP is an important part of Rosatom ensuring nuclear material safeguards at their institutions and represents a clear understanding of how important safeguarding of the nuclear materials is to the future grown of Rosatom Corporation.

Another important change is the establishment of a new Federal Agency for Equipping State Borders. It was reportedly established in October 2007 with the transfer of the customs infrastructure to the new agency with a 10.5 B-Rubles budget from the Federal Target Program for 2008 to provide equipment for the Russian borders.[xiv]

6. Expanded Role of the FSB: The role of the FSB was further expanded in the 2004 and 2005 time period with increased role in the security at nuclear facilities and border regions. The increased role of the FSB is legalized through Presidential Decree #116 dated 2/15/2006 on increased anti-terrorist measures that places the FSB as the lead in combating and responding to terrorism, including nuclear terrorism, at the federal and regional levels. This decree established a new National Antiterrorist Committee headed by the FSB director. It has been reported that there is increased scrutiny of visitors at the nuclear sites now that the role of the FSB has been expanded. It is perceived that it is therefore more difficult for nonproliferation and counter-terrorism activities to take place.

FUTURE COOPERATION

The strengthening of the Russian economy through the sale of oil and gas products as part of their national energy strategy creates a new opportunity for US/Russian nuclear cooperation[xv]. It is an opportunity to thank the Russian government and the people within the nuclear industry for allowing numerous countries and organizations to provide safeguards support for their nuclear weapons, nuclear submarines and nuclear complex during a difficult period of change and transition that required significant openness on the part of the Russian government. But with the advent of their new nuclear vision that includes federal and private investment in nuclear infrastructure, safeguards, and border protection it appears that it is time to move to the next stage in nuclear cooperation. Below are some proposed ideas for modifications by Rosatom to further their work in nuclear safeguards and opportunities for international cooperation. Possible areas for future cooperation include:

1. Nuclear material declarations: Rosatom has transitioned from a Federal Agency to a State Corporation with the goal of becoming an international end-to-end nuclear power supplier. Consistent with their goal of openness and transparency Rosatom Corporation should consider openly declaring their national stockpiles of nuclear material. This could be best supported by the funding of the Plutonium Registry program and a similar program for HEU.
2. HEU reduction: There is significantly more HEU within Russia than plutonium. Even with the down-blending of over 330 MT of HEU under the US HEU/LEU program, there is still an estimated total of around 900 MT of HEU (40 to 90%) in storage and in nuclear weapons. HEU is stored, used or processed at an estimated 57 sites distributed geographically across Russia as compared to the estimated 12 sites with plutonium.

   HEU is the primary special nuclear material moving throughout the Russian complex with tens of tons transiting many sites every year as part of the nuclear weapons assembly and disassembly process, preparing for long-term storage, HEU/LEU blend down process, the manufacture of fuel

elements and in the form of spent nuclear fuel elements. HEU is more easily shielded than plutonium and it is difficult to detect as compared to plutonium. And the vast majority of nuclear diversion cases involving special nuclear material have been MEU or HEU rather than plutonium.

Furthermore, a large percentage of the Russian research reactors use HEU. With the expansion of the nuclear power program and the University programs for training students in science and engineering, it is anticipated that the number of research reactors will increase. The FTP for nuclear power also includes ~$5B to provide loans to foreign countries to purchase Russian nuclear power plants. Therefore, it can be anticipated that more foreign students and nuclear plant operators will study in Russia as part of their nuclear power program. Currently there are no rules or guidelines in Russia that require an institute to consider designing a new research reactor system or reconstructing an older system to use LEU. This may be an area where the International Atomic Energy Agency can team to establish international guidelines for new and reconstructed research reactors to consider LEU as a first option.

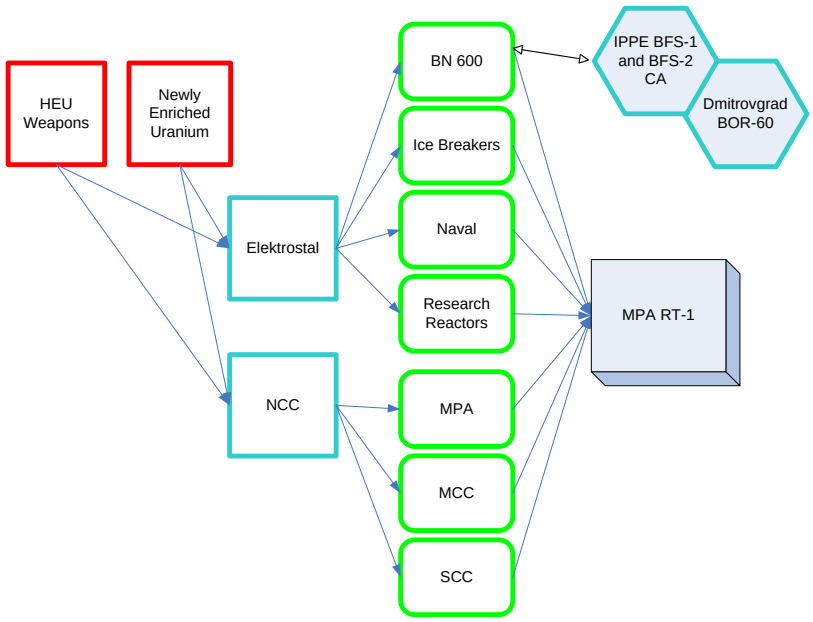

Figure 2: Illustration of the HEU Material Flow for Reactor Operations within Russia

A reduction in the amount of HEU used in nuclear reactors and research reactors will impact many different sites and lesson the proliferation threat.

3. Next Generation Reactors and Fuel Cycle: One of the main issues pressing the US and Russia will be the expansion of nuclear power and the possibility of closing the nuclear fuel cycle. While many groups within the US still considers reprocessing as unnecessary, the Russian's have established reprocessing and the use of reprocessed uranium and plutonium within MOX as the baseline for their next generation of nuclear power generation. There are many questions that will need to be addressed before this technology is brought forward from a technical, nonproliferation, counter-terrorism and ecological impact. This issue can be addressed best within a teaming

arrangement rather than having each nation working separately. Continued work in this area is important.

4. Floating reactors: The Russians are beginning to build medium powered reactors that can be barged to a region to provide power from a water platform. Rosatom has emphasized that they are planning on using LEU fuel in these systems. But perhaps floating reactors are not a safeguards issue, but are rather a possible counter-terrorism target? Joint studies could help identify possible issues to be addressed during the design and construction phase.

5. Russian NPP expansion: The Russian NPP expansion program is in line with the overall Russian government energy and economic development. To help insure independent review, Rosatom may consider bringing in a second country or organization to provide independent review of their nuclear power systems.

6. Nuclear Diversions Cooperation: During the past couple of years there have been two nuclear diversion cases of high importance where the material is believed to have originated within Russia:
    a. June 23, 2003, the arrest of Armenian G. Dadayan with 170 gms of HEU in Georgia, and
    b. February 2006 the arrest of Russian O. Khinsagov in Georgia with 100 gms of HEU.

    It is reported in the press that the material originated from Novosibirsk[xvi] . A 12/20/2002 article from the NTI website suggests that the Russians authorities had discovered a possible leak of HEU during the summer of 2002 from the Novosibirsk Chemical Combine (NCC) during a standard review[xvii]. Based upon reports on the type of material it is possible that the HEU discovered from Georgia was from the NCC or could be legacy material outside of the system. Samples of the material were reportedly provided to the Russian government for review, but the Georgian government did not receive any information back from the Russian government. Both HEU cases were down-played by the Russian government to reduce the international attention on materials safeguards issues. Likewise, many questions remained unanswered regarding the Polonium-210-related death of A. Litvienko in the United Kingdom.

    Russia has a long and complicated history both in their international interactions and with respect to their nuclear safeguards. A clear and open statement on the part of the Russian government would help in the international communications. This also brings up the issue of nuclear forensics – even though it is believed the HEU is from Russia it cannot be proven without the support of the source country. Did the Russian government identify the missing material and is there additional materials missing? Is it possible for nations to share key information regarding material losses under possible emergency conditions and work together within a framework of multi-country detection architecture? In June 2005, it was reported that Russia had 14,000 hits at their radiation detectors at their points of entry with 200 of them involving potential attempts to smuggle nuclear or radiological materials with 80% of the hits from people coming into the country and 20% leaving the country[xviii] [xix]. Would the sharing of this type of information among neighboring countries be helpful in identifying possible nuclear smuggling trends? These questions may be best addressed within the IAEA or the Global Initiative to Combat Nuclear Terrorism.

CONCLUSIONS

The bottom line is that continued discussion and cooperation is critical for both the US and Russia and should be encouraged even during these times of change and transition.

The Russian government and Rosatom has made tremendous progress in addressing their nuclear safeguard issues, yet with each of these changes new challenges appear. The expansion of the civilian nuclear power industry provides new opportunities for openness and full disclosure on nuclear materials and issues with nuclear diversions. A fully integrated government owned, private company creates new issues to ensure the safeguards audits and safety design are truly independent – a difficult task when the country is lined up to meet the future energy and economic goals. And with the economic growth ensuring that sensitive nuclear technologies and capabilities are not transferred under the umbrella of civilian nuclear programs. It is critical that the Russian government rises to meet these difficult challenges during their next major transformation of growth and change.

REFERENCES

[i] Making of the Russian Bomb, T. Cochran et al, Westview Press, 1995.

[ii] SIPRI Russian Nuclear Weapon Estimates, 2006, http://www.sipri.org/contents/expcon/Russia.pdf

[iii] [iii] "I am a "Hawk"", Memoirs of Atomic Energy Minister Mikhaylov, Kron-Press, Moscow 1993. http://www.fas.org/nuke/guide/russia/agency/jptac010_l94001.htm

[iv] Russian Strategic Nuclear Weapons, Pavel Podvig, MIT Press, 1997.

[v] Plutonium and HEU 1996 World Inventories, Capabilities and Policies, D. Albright et al, SIPRI, 1997.

[vi] #3 - JRL Johnsons Russia List, 6537 Moscow Times November 6, 2002, Picture Emerges of How They Did It By Nabi Abdullaev Staff Writer http://www.cdi.org/russia/johnson/6537-3.cfm.

[vii] Nuclear Special Forces Operating in Russia, Rossiyskaya Gazeta, 1/11/2002, V. Bogdanov. Per NTI website; http://www.nti.org/db/nistraff/2002/20020790.htm.

[viii] Nuclear News, 2005.

[ix] Galya Balatsky summary 11/18/2005.

[x] RIA Novosti per B. Burgess 3/13/2007.

[xi] Galya Balatsky summary 2/12/2007 per Neftegazexpert 12/28/06.

[xii] RIA Novesti, Moscow, per B. Burgess 3/13/2007.

[xiii] Russian Federal Target Program for the Development of the Nuclear Power Industry Complex for 2007 to 2010 and Further to 2015 approved by President Putin 10/6/2006. Binning of information by category by S. Voss.

[xiv] Kommersant.com headline: Economics Ministry Forms Border Agency - Kommersant Moscow CEP20071018950089 Moscow Kommersant.com in English 0815 GMT 18 Oct 07.

[xv] Russia's Future: The Precarious Balance between Russian Energy and Military Strategy, S. Voss, GNNA, LLC. Project on Nuclear Issues, CSIS, 2008.

[xvi] Smuggler's Plot Highlights Fear Over Uranium, The New York Times January 25, 2007, L. Scott Sheets and W. Broad.

[xvii] Bomba dlya gubernatora [A bomb for the governor], Novaya Sibir, A. Kuznetsov, 12/20/2002 per NTI web site: http://www.nti.org/db/nistraff/2002/20020900.htm.

[xviii] Testimony of David Huizenga for the House Committee on Homeland Security, 2005, 6/05.

[xix] IBR S. Danilov e-mail 2005.